T. BUNCLE AND CO. LTD., ARBROATH, ANGUS, SCOTLAND.

ED-S678.7T

VOL. 18 PART 8

TRANSACTIONS

OF THE

SOCIETY FOR BRITISH ENTOMOLOGY

World List abbreviation: *Trans. Soc. Brit. Ent.*

CONTENTS.

T. R. New

The Biology of Some Species of *Alaptus* (Mymaridae) Parasitising Eggs of Psocoptera

Date of Publication, March 1969

Copies may be purchased from G. R. Gradwell, Hope Department of Entomology, University Museum, Oxford

Price 6/6 post free

Published for the Society
by the British Trust for Entomology Ltd.

THE BRITISH TRUST FOR ENTOMOLOGY

ADDRESSES

REGISTERED ADDRESS—41 Queens Gate, London, S.W.7.

EDITORIAL—The Editors: Dr. E. J. Popham, Dept of Biology, The University, Salford, Lancs.

Dr. R. R. Askew and Dr. J. H. Kennaugh, Dept. of Zoology, The University, Manchester 13.

SUBSCRIPTIONS, SALES and MEMBERSHIP—The Secretary, G. R. Gradwell, Hope Dept. of Entomology, University Museum, Oxford.

PUBLICATIONS

THE ENTOMOLOGIST. Published monthly, one volume per annum. Subscription rate 35/- per annum.

THE TRANSACTIONS OF THE SOCIETY FOR BRITISH ENTOMOLOGY. Published irregularly, one volume every two years. Subscription rate 30/- per annum.

Members of the Trust may subscribe to both periodicals at a combined subscription of 55/- per annum.

COUNCIL OF MANAGEMENT

Chairman: G. C. Varley, M. A., Ph.D., F.Z.S., F.R.E.S.
R. R. Askew, B.Sc., D.Phil., F.R.E.S.
M. F. Claridge, B.A., D.Phil., F.R.E.S.
R. A. French, B.Sc., F.R.E.S.
G. R. Gradwell, M.A., F.R.E.S.
B. M. Hobby, M.A., D.Phil., F.L.S., F.Z.S., F.R.E.S.
G. J. Kerrich, M.A., F.L.S., F.R.E.S.
H. N. Michaelis.
E. J. Popham, D.Sc., Ph.D., A.R.C.S., F.Z.S., F.R.E.S.
N. D. Riley, C.B.E., F.Z.S., F.R.E.S.
T. R. E. Southwood, D.Sc., Ph.D., A.R.C.S., F.R.E.S.
H. F. van Emden, B.Sc., Ph.D., A.R.C.S., F.R.E.S.

Other members of the editorial board:

A. Brindle, F.R.E.S.
A. E. Gardner, F.R.E.S.
H. E. Hinton, B.Sc., Ph.D., Sc.D., F.R.S., F.R.E.S.
C. Johnson, F.R.E.S.
H. B. D. Kettlewell, M.A., M.B., B.Chir., F.R.E.S.
O. W. Richards, M.A., D.Sc., F.R.S., F.R.E.S.

TRANSACTIONS OF THE SOCIETY FOR BRITISH ENTOMOLOGY

VOL. 18 MARCH 1969 PART VIII

The Biology of Some Species of *Alaptus* (Mymaridae) Parasitising Eggs of Psocoptera

By T. R. New

(Imperial College Field Station, Silwood Park, Sunninghill, Ascot, Berks.

Psocoptera are parasitised by members of two groups of hymenopterous insects. The biology of a genus of Mymaridae which are frequent parasites of Psocid eggs is described in this paper. The Braconid parasites of Psocid nymphs and adults will be discussed later.

The Mymaridae, without exception, are parasites of the eggs of other insects. About 1100 species of Mymaridae are known, but the biology of only about twenty of these has been studied. The genus *Alaptus* has been recorded from Coccids (Mani, 1942), Aleyrodids (see Nikolskaya, 1952) and Psocoptera. Annecke and Doutt (1961) recorded the known distribution of this genus as 'Europe, Africa, U.S.A., Haiti, Peru, Australia, China, India': it may well prove to be cosmopolitan. Hincks (1959) recognised five British species of *Alaptus* and more recently (1960) described *A. richardsi* which was reared from Psocid eggs (probably of *Caecilius flavidus* Stephens) at Silwood Park.

Alaptus is the only genus of Mymaridae, bred from Psocid eggs, which is available for study, and appears to be the only genus which parasitises Psocids in Britain. Species of several other Mymarid genera (*Ooctonus, Mymar, Anaphes, Enaesius* were confined with freshly laid Psocid eggs at Silwood Park, but they failed to parasitise them. Vishniakova (1959) recorded *Parvulinus* and *Anaphes* from eggs of several Psocid species in the Soviet Union but examination of this material, kindly loaned by her, has revealed only *Alaptus*. *Parvulinus* Mercet 1912 is now considered to be a synonym of *Alaptus* Haliday in Westwood 1839 (see Annecke and Doutt, 1961), but was separated in Nikolskaya's (1952) key to Soviet Chalcidoidea.

There are a number of references to specific Psocid hosts of named species of *Alaptus,* but early specific identifications of these Mymarids cannot be accepted unless the actual specimens are available for examination (see Hincks, 1959). The taxonomy of some of the British species is to be reviewed in the near future by Broadhead and Clarke (in prep.) and it is not proposed to discuss the adult taxonomy here.

Jackson (1961) reviewed the kinds of Mymarid larvae known up to that date. The larva of *Alaptus minimus* Haliday in Walker was briefly described by Bakkendorf (1934) and the early stages of *A. fusculus* Haliday in Walker mentioned by Broadhead and Wapshere (1966). Spruyt (1927) gave notes on the biology of *A. psocidivorus* Gahan, but there are no fuller accounts of the life histories and biology of these Mymarids.

Methods

Many egg batches of foliage-frequenting Psocids were collected from litter and various species of trees at Silwood Park and other sites in the south and east of England. About ten per cent of these were parasitised (almost all by *A. pallidicornis* Foerster and a small proportion by *A. richardsi* Hincks), and this proportion did not vary greatly between batches from different sites and at different times of the year. Eggs of bark-frequenting Psocids were collected at intervals, and parasitism varied between ten and thirty per cent.

Parasites usually emerged within a fortnight from host eggs kept in the laboratory, and development of the parasites varied with temperature. Adult *Alaptus* readily oviposited in newly laid Psocid eggs, and a constant supply of these was maintained from caged Psocids. Host eggs of known ages could, therefore, be easily supplied to parasites. The host eggs were dissected at known times after parasite oviposition, in either Insect Ringer Solution or Kahle's Fluid, in cavity slides. The eggs and young larvae were teased from the host egg contents with fine needles and examined after mounting and staining either in Hoyer's Fluid with lignin pink or in lactophenol with aniline blue. The larger larvae and pupae are usually partially visible through the chorion of the host egg and are easier to dissect out. Adults were dissected after hardening in Kahle's Fluid and mounted in *lactophenol* containing aniline blue.

Early Stages and Life History

Egg. The egg of *Alaptus* is pedunculate and of the general form found in many Mymarids (Clausen, 1940). The freshly laid egg is slender with a relatively short pedicel, but this soon develops into a more ovoid egg with a longer pedicel (Fig. 1a).

Larva. Bakkendorf (1934) considered that *Alaptus* had two larval instars but later authors (Jackson, 1961; Broadhead and Wapshere, 1966) implied that there are three. I have found three distinct stages in *A. pallidicornis* and *A. richardsi* and these corresponded well to the stages of *A. fusculus* noted by Broadhead and Wapshere (Figs. 1b-d).

The first stage larva has small pointed mandibles, but there are no other cephalic sclerites or other cuticular projections. There is a small frontal process and a tapering cauda which may be partially divided at the tip. No segmentation is visible.

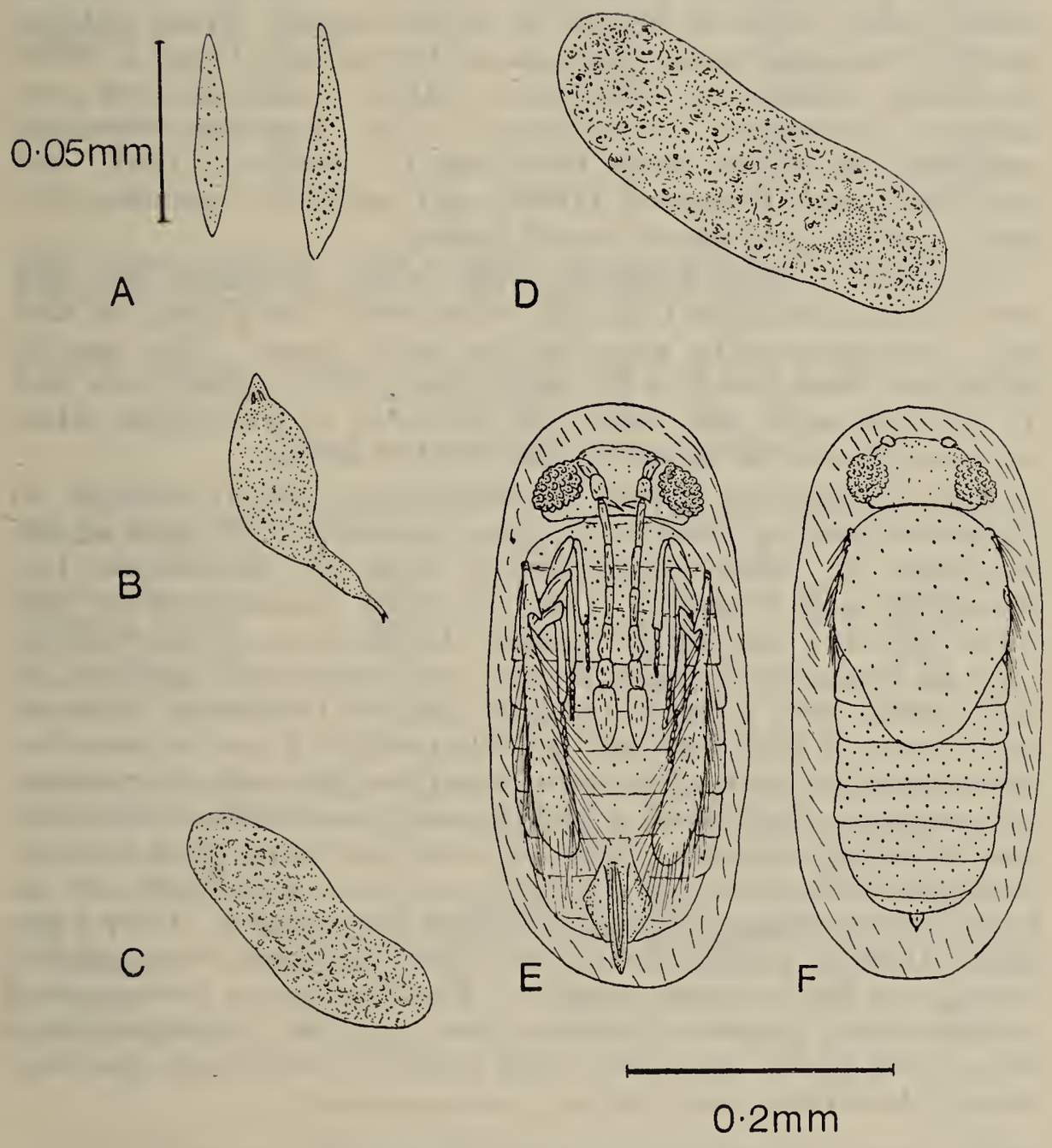

FIG. 1

Early stages of *Alaptus richardsi* Hincks.

A: Ovarian eggs. B: First instar larva. C: Second instar larva. D: Third instar larva. E, F: Pupa in host egg (E, ventral; F, dorsal) (larvae and pupa to same scale).

The seeond stage larva has lost the mandibles and mueh of the eauda and is larger.

The third stage almost eompletely fills the host egg. It is eylindrieal but no external strueture is visible. There are no mouthparts and no setae or spines on the eutiele. The posterior part of this larva usually eontains an irregular white or yellow patch, which is absent in earlier stages. These patehes probably represent waste produets and have been found in other Mymarids. However, Bakkendorf (1934) failed to find any mid-gut coneretions in *Alaptus*. The partieles observed resembled the white spots deseribed by Jaekson (1961) and Broadhead and Wapshere (1966), and probably represent the final digestion produets of larval feeding.

There is a short prepupal stage whieh resembles the last larval instar, but there is no gut movement. The pupa is at first pale, but darkens to resemble the adult inseet. No specific differences were found in the early stages of *A. pallidicornis* and *A. richardsi* until just before the hatehing of the adults, when the pupa shows the charaeteristie adult features.

The life histories of both *A. pallidicornis* and *A. richardsi* on foliage-frequenting Psocids eontrast markedly with that of the univoltine *A. fusculus* parasitising eggs of *Mesopsocus* (see Broadhead and Wapshere, 1966): the life histories of the different parasites are elosely eorrelated with those of their hosts. Eggs of foliage-frequenting Psoeids are eontinually present on many trees from June to Oetober, and on trees or in litter at other times of the year, and provide possible hosts for parasites throughout the year. The duration of the life eycle (oviposition to emergence of adult) of *A. pallidicornis* in an outdoor insectary was 18-25 days and this, together with the unchanging levels of parasitism throughout the summer, suggests that there are six to eight overlapping generations during the summer. Only a few adult *Alaptus* were found in the field, but they were present throughout the summer months. Most specimens overwintered as diapausing pupae within the host egg, but prepupae, large larvae and a few eggs were also found in host eggs dissected during the winter.

The Effect of Host on Parasite

The size and duration of development of many polyphagous egg parasites differ in different hosts. Table 1 shows the duration of development of *A. pallidicornis* in eggs of three Psocid species. All parent females were from elonal material bred in eggs of *C. flavidus* and then transferred also to smaller eggs (*Ectopsocus briggsi* MeLaehlan) or larger eggs (*Stenopsocus immaculatus* Stephens). The sizes of parasites reared from these hosts are compared in Table 2. Larger parasites were bred from larger host eggs and also took longer to develop. Table 3 indieates

TABLE 1. Times of development of *Alaptus pallidicornis* Foerster in the eggs of three psocid species.

Host Species	Number	Temperature (°C.)	Total Developmental Time (Days) Minimum	Mean	Maximum
C. flavidus	35	15	24	27	32
	30	20	18	23·4	29
	28	25	17	19·5	22
E. briggsi	30	15	21	24	28
	32	20	18	22·6	26
	30	25	16	18·3	22
S. immaculatus	30	15	26	30·6	36
	27	20	22	25	29
	28	25	18	22·4	26

that larger females lived slightly longer, but their fecundity did not differ greatly from that of smaller individuals.

TABLE 2. Sizes of *Alaptus pallidicornis* bred from eggs of three species of psocids.

(Mean measurements in mm ±0·003)

Host:	*C. flavidus*	*E. briggsi*	*S. immaculatus*
No. female parasites	20	20	20
Antenna length	0·384	0·340	0·425
Forewing length	0·464	0·446	0·528
Hindwing length	0·458	0·444	0·521
Thorax length	0·260	0·250	0·264
Ovipositor length	0·146	0·142	0·158

TABLE 3. Longevity and fecundity of *Alaptus pallidicornis* females bred from eggs of three species of psocids at 20°C. (food provided)

Host	Number	Longevity (Days) Minimum	Mean	Maximum	Total progeny reared Mean	Extremes
C. flavidus	20	11	15	20	62	43-87
E. briggsi	20	8	13·5	17	56	31-80
S. immaculatus	20	10	15·3	19	61	49-76

Parthenogenesis and Sex Ratio

All species of *Alaptus* studied exhibit parthenogenesis. Males of *A. richardsi* are unkown, and this species appears to be thelytokous: the bisexual species examined (*A. pallidicornis, A. fusculus, A. minimus*) are all amphitokous. Numerous attempts to observe mating of these species in the laboratory failed. Virgin pairs of insects confined in small tubes or in gelatine capsules showed only casual interest in each other. The sex ratios of samples of *A. pallidicornis* reared from field-collected eggs of *C. flavidus* in 1966 are shown in Table 4. Collections of parasites at several times of the year gave sex ratios which did not differ consistently from unity. Similar results were obtained from the

TABLE 4. Sex ratios of *Alaptus pallidicornis* bred from field-collected eggs and in laboratory stocks

a. Field collections

Date of Collection	Total Parasites	Males : Females
November 1965	184	82 : 102
March 1966	230	106 : 124
June 1966	78	34 : 44
August 1966	218	130 : 88
October 1966	283	136 : 147
March 1967	320	143 : 177
June 1967	260	125 : 135
August 1967	242	108 : 134
October 1967	294	166 : 128

b. Progeny of isolated virgin females in the laboratory

Age of Host Eggs (Days)	Total Parasites bred	Males : Females
0-1	168	72 : 96
2-3	314	186 : 128
5	86	31 : 55
7	152	89 : 63
10	57	24 : 33

progeny of isolated virgin females, and in host eggs of several ages. These results contrast markedly with Jackson's (1966) data on *Caraphractus cinctus* Walker, which is arrhenotokous; female progeny were reared only from mated females.

Longevity, Oviposition and Fecundity

In the laboratory adult *Alaptus* lived for periods varying from five to nineteen days. They were kept in polystyrene petri dishes and provided with small pieces of raisins and pads of sugared water but were only rarely seen to feed, although adults provided with food lived longer than those deprived of food (Table 5). An experiment in which single adults were kept in small tubes with food indicated that females lived longer than males (Table 6).

TABLE 5. The effect of food on the longevity of *Alaptus pallidicornis* bred from *Caecilius flavidus*

Food :—	Number of Parasites	Longevity (Days)	Mean Longevity
Present	73	8-15	11·8
Absent	58	10-19	15

TABLE 6. The longevity of male and female *Alaptus pallidicornis* (food provided)

Sex	Number of Parasites	Longevity (days)	Mean Longevity
Male	46	11-17	14·3
Female	38	13-19	15·8

Female *Alaptus* can oviposit immediately after leaving the host egg. Oviposition was repeatedly observed in four species of *Alaptus* and was similar on all occasions. There are no constant differences in oviposition behaviour in the different species. The female moves around until a batch of host eggs is encountered. She then walks on to the batch, continuously tapping the substrate with the clubs of her antennae. When a 'suitable' egg has been found she straddles it, or the overlying web, and may then remain motionless for several minutes. The abdomen is then raised and the ovipositor inserted into the egg. The wings are held flat along the body throughout this period and the antennae point forwards and diverge; when testing possible host eggs the antennae are held close togther, and may touch. Slight rocking movements of the body usually occur during oviposition but the legs are not normally shifted. The ovipositor remains inserted for several minutes (Table 7), and

TABLE 7. Times of oviposition of *Alaptus pallidicornis*

Age of Female (Days)	Number of Females	Number of Observations of Oviposition	Duration of Oviposition (Minutes) Extremes	Mean
1	25	37	6-27	12·6
2-3	25	46	4-18	9·8
5	25	28	3-14	7
7-8	17	29	8-22	14·4
10-12	20	37	3-16	9·5
16-18	4	8	5-11	8·5

whilst ovipositing the female does not react to external stimuli such as bright light, heat, tapping the substrate and even to being touched by other parasites. Up to three females have been observed simultaneously ovipositing in the same egg batch without mutual interference. An egg batch bearing an ovipositing *Alaptus* can safely be moved and carried around without fear of losing the insect. Withdrawal of the ovipositor takes about half a minute, and the female may then flex her wings and clean her antennae before moving to another egg. There does not appear to be any clear marking of parasitised eggs by the female, but *Alaptus* very rarely attempt to oviposit in an already parasitised egg although they may examine it for several minutes. They will also examine very old (previous season) dead or hatched eggs and occasionally probe them with their ovipositors. Lloyd (1956) considered that parasite oviposition was often accompanied by deposition of a characteristic secretion from the accessory gland. This form of marking is known in some egg parasites (see Wilson, 1961) but close observation of isolated *Alaptus* failed to reveal any fluid deposited *on* to the egg. Jackson (1966) showed that deposition of a Mymarid egg into a host egg rendered the host unacceptable to future parasites. She suggested that a repellant substance was injected into the host at oviposition and that the

parasite's ovipositor bore sense organs which perceived this substance. The female *Alaptus* has a small reservoir at the base of the ovipositor, similar to that in *Caraphractus,* and it is likely that a similar method of marking the host occurs in both genera.

Several unrelated female *Alaptus* may oviposit in different eggs of the same batch, and any subsequent mating between unrelated progeny from these eggs ensures some genetic interchange. Hincks (1961) recorded rearing individuals of two species (*A. pallidicornis* and *A. richardsi*) from the same batch of host eggs. More than one egg or larva has never been found in one host egg at Silwood Park: superparasitism is thus extremely rare. Broadhead and Wapshere (1966) sometimes found two individuals of *A. fusculus* in a *Mesopsocus* egg but, again, this was rare.

Psocids and parasites were often bred from the same batch of foliage-frequenting Psocid eggs. All the Psocid eggs in a batch are of about the same age, but parasites may move off the batch before laying in all the eggs. This habit is not due to inability to lay several eggs at short intervals as several young females which had left batches containing unparasitised eggs readily accepted, and laid in, eggs in other batches immediately afterwards. The sizes of field-collected egg batches of *C. flavidus* from which *A. pallidicornis* emerged are enumerated in Table 8. Some batches

TABLE 8. The size of parasitised egg batches of *C. flavidus* collected from oak trees at Silwood Park, 1966-1967
(total batches: 66)

Eggs per batch	Number batches	Number fully parasitised	Number with developing psocids	Number with dead eggs
2	1	0	1	0
3	4	3	1	0
4	6	5	1	0
5	11	7	4	0
6	5	4	1	3
7	12	5	7	0
8	21	15	6	5
9	2	2	0	1
10	2	2	0	0
11	2	0	2	0

of all sizes from two to eleven eggs yielded both parasites and Psocids: there was therefore no evident correlation between batch size and amount of parasitism. Twenty batches each of four to ten eggs were given separately to young female *Alaptus* (under one week old) for two days in the laboratory. Some batches of all sizes were incompletely parasitised (Table 9). The age of the female parasite does not markedly affect the amount of parasitism up to about ten days (Table 10). Oviposition ceases about this time, which probably reflects the maximum field longevity of the parasite,

TABLE 9. Laboratory experiments of the amount of parasitism of *C. flavidus* egg batches of different sizes by *A. pallidicornis* (20 batches of each size)

Batch size (number eggs)	4	5	6	7	8	9	10
Number batches fully parasitised	18	16	12	19	18	14	12
Number with developing psocids	2	4	8	1	2	6	8

TABLE 10. The amount of parasitism of *C. flavidus* eggs by female *Alaptus* of different ages

Age of female (days)	Number of females	Total eggs offered (1 batch per female per day)	Total eggs parasitised	Per cent parasitism
1	23	162	143	88·3
2	23	160	152	95·0
3	23	149	130	87·2
4	23	158	137	86·7
5	23	164	142	86·5
6	23	153	120	78·4
7	23	159	134	84·3
8	21	139	114	82·0
9	20	142	105	73·9
10	17	138	113	81·9
11	16	124	89	71·8
12	12	88	34	38·6
13	12	94	11	11·7
14	9	68	0	0·0
15	8	52	0	0·0

Alaptus have well-developed eggs in the two fan-shaped ovaries at the time of emergence. Feeding is not necessary for initial oviposition and although the longevity of adults is greater when food is available the fecundity does not change greatly. It is implied that food causes little further differentiation of oocytes. Dissections of females of known ages showed that they contained the greatest numbers of eggs soon after hatching and that there was a progressive decline with age.

In order to gain an estimate of the fecundity of *Alaptus* in the laboratory single females of *A. pallidicornis* and *A. richardsi* were provided with freshly laid (one or two days old) egg batches of *C. flavidus* in petri dishes maintained at 100 per cent relative humidity. Fresh batches were provided on alternate days and the batches previously present were removed and dissected. At least 40 host eggs were always available to each parasite. Total counts of eggs and young larvae of *Alaptus* in the host eggs gave a measure of the fecundity. The results (Table 11) showed that females of these two species often laid from 50 to 80 eggs. These figures are probably rather higher than would be expected in the field, as in the laboratory a regular supply of fresh suitable hosts was available in a small search area.

TABLE 11. The fecundity of *Alaptus pallidicornis* and *A. richardsi* on eggs of *C. flavidus* in the laboratory

Species	Number	Number of progeny reared		
		Minimum	Mean	Maximum
A. pallidicornis	20	38	57·5	82
A. richardsi	20	47	69	76

Host-finding and Host Specificity

The adult parasites fly regularly in the laboratory, but appear to search for hosts mainly by running and short flits. It is likely that such small insects as *Alaptus* and other Mymarids can control their flight to a very small extent in even a gentle breeze, and much loss and redistribution of the adults must occur because of this. Host-finding by walking, without taking to flight, may thus conserve a higher proportion of the parasite population in the original habitat where there may be a constant supply of hosts throughout the summer. Nevertheless, considerable dispersal does occur as *Alaptus* were bred from the earliest eggs of *C. flavidus* found on trees after flight of the Psocids from the litter in spring. They were bred from eggs collected on all species of trees examined, on all parts of trees, and occurred in all the habitats in which host eggs were present.

Single young females of *A. pallidicornis* were confined on small potted oak trees on which numbers of fresh *C. flavidus* egg batches were pinned at different points Many parasites were lost in this experiment, but others laid in most of the available egg batches (Table 12). Batches 80-85 cm. apart on the same

TABLE 12. Parasitism of egg batches of *C. flavidus* on small potted oak trees by *A. pallidicornis*

Female	Total No. of batches offered	Total batches parasitised
1	26	21
2	18	14
3	30	27
4	15	2
5	14	8
6	23	11
7	23	3
8	22	18
9	14	9
10	34	8
11	21	16
12	9	7
13	26	24
14	18	5
15	18	14
16	29	22
17	17	13

tree, and with intervening foliage and branches, were parasitised by the same individual on the same day. This experiment indicated that *Alaptus* searches efficiently over distances such as this.

Only young eggs of foliage-frequenting Psocids are acceptable to *A. pallidicornis* and *A. richardsi*. Laboratory tests (Table 13)

TABLE 13. The effect of host age on parasitism by *Alaptus* females up to five days old

Age of host eggs (days)	Number of parasites	Number of ovipositions observed	Number of progeny reared
0-1	20	37	34
2-3	20	52	51
5	20	32	9
10	20	4	0
15	20	1	0

showed that oviposition was attempted, sometimes successfully, in older eggs, but parasites only rarely developed in host eggs which had progressed to the stage where traces of the Psocid embryo are clearly visible through the chorion. Eggs of *Alaptus* were sometimes found in host eggs dissected at this time, but no later stages of the parasites were ever found.

The few reliable specific host records in the literature of the *Alaptus* species which parasitise Psocoptera indicate that there is some host specificity. *A. pallidicornis* and *A. richardsi* have been reared mainly from eggs of foliage-frequenting Psocids and not from the bark-frequenting species, whereas the reverse is true of *A. fusculus* and *A. minimus*. These indications were borne out by field egg samples at Silwood. The range of Psocid hosts of these four species found at Silwood Park was investigated in the laboratory by providing them with eggs of all available Psocid species, obtained from captive female Psocids. Each result given in Table 14 is based on at least five parasite females and twenty

TABLE 14. Host specificity of *Alaptus* species parasitising psocid eggs at Silwood Park

	Parasite							
	A. pallidicornis		*A. richardsi*		*A. fusculus*		*A. minimus*	
	Wild	Lab.	Wild	Lab.	Wild	Lab.	Wild	Lab.
Psocid Genus	Eggs		Eggs		Eggs		Eggs	
Caecilius	A	A	A	A	X	B	X	X
Stenopsocus	A	A	A	A	X	B	X	X
Graphopsocus	A	A	A	A	X	B	X	X
Ectopsocus	A	A	X	A	X	X	X	X
Trichopsocus	X	B	X	X	X	A	X	X
Elipsocus / *Cuneopalpus* / *Philotarsus*	X	B	X	X	A	A	A	A
Mesopsocus	X	X	X	X	A	A	A	O
Amphigerontia	X	X	X	X	A	O	X	O
Peripsocus	X	X	X	B	X	O	X	O
Cerobasis	X	X	X	X	A	O	X	O
Liposcelis	O	X	O	X	O	X	O	O

(A: successful rearing; X: not found, or no interest shown; B: oviposition observed, but no progeny reared; O: no data)

eggs of each host species, and both attempted ovipositions and successful rearings are noted. The results obtained closely bear out the inferences in the literature that there is a clear separation between the *Alaptus* species parasitising foliage Psocids and those affecting bark Psocids. It is notable that the eggs of *Trichopsocus dalii* (McLachlan), which resemble those of many bark-frequenting Psocids but are laid on foliage, were successfully parasitised by *A. fusculus* in the laboratory and not by *A. pallidicornis*. Both categories of *Alaptus* sometimes attempted to oviposit in eggs of the other Psocids, but were very rarely reared from these species. It thus seems that there is a clear division between *Alaptus* species affecting eggs of the two main categories of arboreal Psocoptera. The reactions of different host eggs to the early stages of different *Alaptus* species have not been studied, but may differ. None of the few Mymarid eggs and young larvae found in alien hosts showed any signs of encapsulation.

Summary

Alaptus pallidicornis and *A. richardsi* were bred from eggs of foliage-frequenting Psocids at Silwood Park, and *A. minimus* and *A. fusculus* from those of bark-frequenting Psocids. This division of hosts was supported by laboratory experiments.

Alaptus species have three larval instars, the first being mandibulate and later instars sacculate. The life histories of different species are closely correlated with those of their hosts. *A. pallidicornis* and *A. richardsi* have several overlapping generations each year. The size of these species varies with that of the host. The male of *A. richardsi* has not been found, but the bisexual species are facultatively parthenogenetic, unmated females produced progeny of both sexes. Many egg batches found were incompletely parasitised. This is not related to the size of the batch and is not due to the female's inability to lay. Several females may oviposit in the same host egg batch.

Acknowledgments

This paper contains data submitted in a thesis for the Ph.D. degree of London University. The work described was carried out at the Imperial College Field Station, Silwood Park, during the tenure of a Science Research Council Research Studentship. I wish to thank my supervisor, Dr N. Waloff, for her interest and encouragement, and Dr. E. Broadhead (Leeds) for reading the manuscript.

References

Annecke, D. P. & Doutt, R. L. 1961. The Genera of the Mymaridae (Hymenoptera: Chalcidoidea). *Entomology Memoirs*, 5: 1-71 (Dept. Agric. Technical Services, Government Printer, Pretoria).

Bakkendorf, O. 1934. Biological Investigations on some Danish Hymenopterous Egg-parasites, especially in Homopterous and Heteropterous eggs, with Taxonomic Remarks, and Descriptions of New Species. *Ent. Meddel.*, **19**: 1-134.

Broadhead, E. & Wapshere, A. J. 1966. *Mesopsocus* Populations on Larch in England — The Distribution and Dynamics of Two Closely-related Coexisting Species of Psocoptera Sharing the Same Food Resource. *Ecol. Monogr.*, **36**: 327-388.

Clausen, C. P. 1940. *Entomophagous Insects.* London and New York.

Hincks, W. D. 1959. The British species of the genus *Alaptus* Haliday in Walker (Hym., Chalc., Mymaridae). *Trans. Soc. Brit. Ent.*, **13**: 137-148.

Hincks, W. D. 1960. A new British species of the genus *Alaptus* Haliday (Hym., Mymaridae). *Entomologist*, **93**: 170-172.

Jackson, D. J. 1961. Observations on the biology of *Caraphractus cinctus* Walker (Hymenoptera: Mymaridae) a parasitoid of the eggs of Dytiscidae (Coleoptera). II. Immature stages and seasonal history with a review of Mymarid larvae. *Parasitology*, **51**: 269-294.

Jackson, D. J. 1966. Observations on the biology of *Caraphractus cinctus* Walker (Hymenoptera: Mymaridae) a parasitoid of the eggs of Dytiscidae (Coleoptera). III. The adult life and sex ratio.

Lloyd, D. C. 1956. Studies on parasite Oviposition Behaviour. I. *Mastrus carpocapsae* Cushman. *Canad. Ent.*, **88**: 80-89.

Mani, M. S. 1942. Studies on Indian Parasitic Hymenoptera—II. *Ind. J. Ent.*, **4**: 153-162.

Nikolskaya, M. N. 1952. *Chalcidoidea of the Soviet Union.* Moscow (in Russian).

Spruyt, F. J. 1927. Notes on *Alaptus psocidivorus* Gahan, a new species of Mymaridae (Hymenoptera). *Pan-Pacif. Ent.*, **3**: 182-184.

Vishniakova, V. N. 1959. On the fauna and ecology of Psocoptera of Moscow and Ryazan regions of the U.S.S.R. *Rev. Ent. U.R.S.S.*, **38**: 435-442. (in Russian, English summary).

Wilson, F. 1961. Adult Reproductive Behaviour in *Asolcus basalis* (Hymenoptera: Scelionidae). *Aust. J. Zool.*, **9**: 737-751.

MCZ ERNST MAYR LIBRARY
3 2044 118 699 107

Date Due